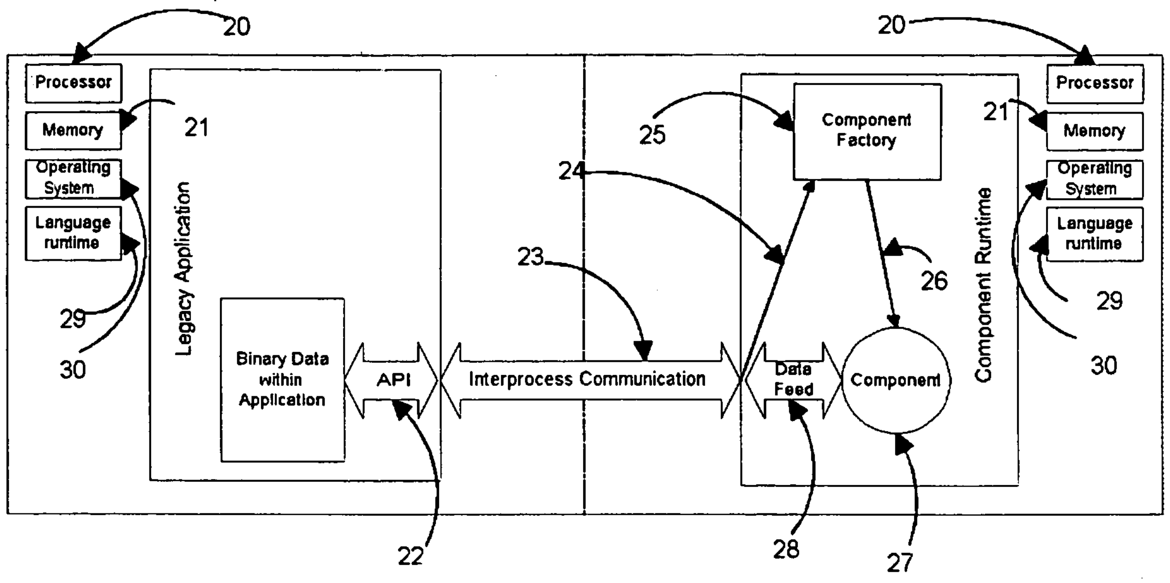
20
Processor
Memory
Operating System
Language runtime
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Legacy Application
Binary Data within Application
API
22
Interprocess Communication
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Component Factory
26
Data Feed
Component
Component Runtime
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Processor
21
Memory
Operating System
Language runtime
29
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Fig. 1

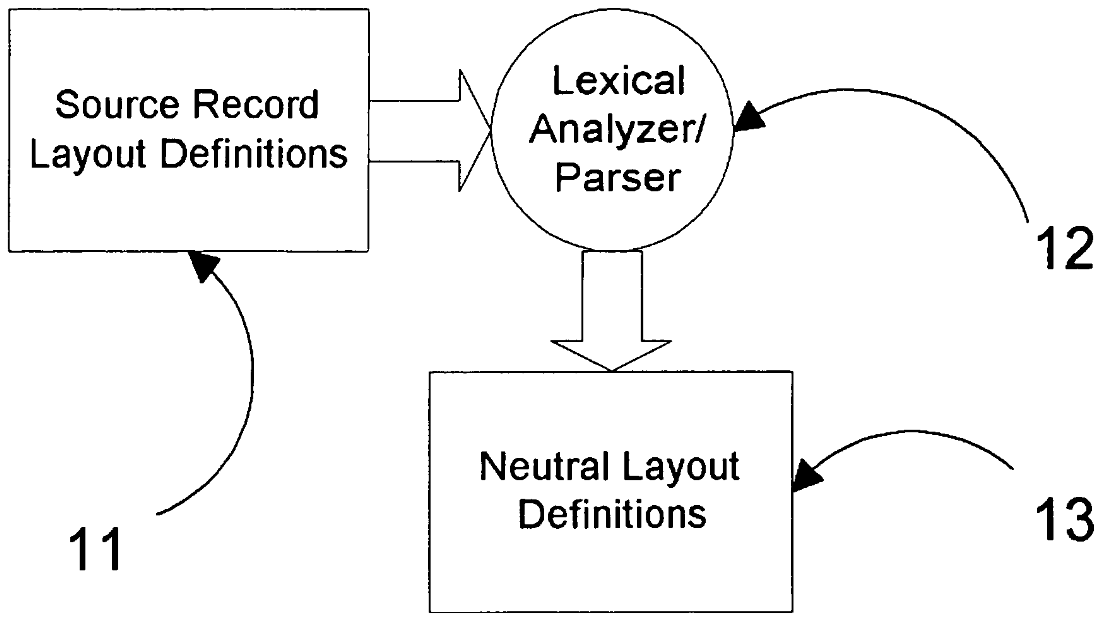

Source Record Layout Definitions
Lexical Analyzer/ Parser
Neutral Layout Definitions
11
12
13

Fig. 2

```
01  STUDENT-SUMMARY-INFORMATION.
    05  ID-NUMBER                PIC 9(6).
    05  PIN                      PIC 9(6).
    05  NAME                     PIC A(35).
    05  ADDRESS                  PIC A(25)
           OCCURS 3 TIMES.
    05  PHONE-NUMBER             PIC 999-999-9999.
    05  SOCIAL-SECURITY-NUMBER   PIC 999-99-9999.
    05  GRADE-POINT-AVERAGE      PIC 9V99.
    05  BALANCES.
        10 TUITION               PIC S9(5) COMP-3.
        10 HOUSING               PIC S9(5) COMP-3.
```

Fig. 3

```
<?xml version="1.0"?>
<!DOCTYPE record SYSTEM "/XML/Meta/tmeta.dtd">
<record name="STUDENT-SUMMARY-INFORMATION" architecture="s390" align="1">
   <field type="pic" align="1" spec="999999" size="6">
      <name>ID-NUMBER</name>
      <association>ID-NUMBER</association>
   </field>
   <field type="pic" align="1" spec="999999" size="6">
      <name>PIN</name>
      <association>PIN</association>
   </field>
   <field type="pic" align="1" spec="XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX" size="35">
      <name>NAME</name>
      <association>NAME</association>
   </field>
   <array size="3">
      <name>ADDRESS</name>
      <association>ADDRESS</association>
      <field type="pic" align="1" spec="XXXXXXXXXXXXXXXXXXXXXXXXX" size="25">
         <name>ADDRESS</name>
         <association>ADDRESS</association>
      </field>
   </array>
   <field type="pic" align="1" spec="999X999X9999" size="12">
      <name>PHONE-NUMBER</name>
      <association>PHONE-NUMBER</association>
   </field>
   <field type="pic" align="1" spec="999X99X9999" size="11">
      <name>SOCIAL-SECURITY-NUMBER</name>
      <association>SOCIAL-SECURITY-NUMBER</association>
   </field>
   <field type="pic" align="1" spec="999" shift="-2" size="3">
      <name>GRADE-POINT-AVERAGE</name>
      <association>GRADE-POINT-AVERAGE</association>
   </field>
   <struct>
      <name>BALANCES</name>
      <association>BALANCES</association>
      <field type="packed" align="1" size="3">
         <name>TUITION</name>
         <association>TUITION</association>
      </field>
      <field type="packed" align="1" size="3">
         <name>HOUSING</name>
         <association>HOUSING</association>
      </field>
   </struct>
</record>
```

Fig. 4A

```
package com.touchnet.beangen;

import com.touchnet.base.*;
import java.io.*;
import java.util.*;

/**
 * This will provide the functionality that is common to all generated JavaBeans that
 * map into legacy structures
 *
 * Creation date: (12/14/99 1:28:08 PM)
 * @author: Gary Murphy
 */
public abstract class AbstractStructure
    implements StructureInterface
{
    private String                  architecture;
    private StructTreeNode          root    = null;
    private BinaryRenderingEngine engine = new BinaryRenderingEngine();
    private java.lang.String metadataName;
/**
 * Create the base constructure for Java objects that wrapper legacy data
 * structures
 */
public AbstractStructure()
    {
    super();
    }
/**
 * Access the name of the architecture that the underlying binary data
 * represents
 */
public String getArchitecture()
    throws TException
    {
    return architecture;
    }
/**
 * This will access an array within the structure.  It will be returned as
 * an array of some concrete instance of this AbstractStructure.  Even if
 * the array is of a single field, it will still be represented as a
 * structure that simply contains a single element.  If the requested
 * element is not an array, this will throw an exception
 */
public StructureInterface[] getArray(String name)
    throws TException
    {
    AbstractStructureTreeNode node = getNode(name);
    if (node instanceof ArrayTreeNode)
        {
        ArrayTreeNode arrayNode = (ArrayTreeNode)node;
        return arrayNode.getArray();
        }

    // If this isn't an array node, then we tried to access a non-array
    // as an array

    throw new TException("Attempt to access a non-array element as an array");
    }
/**
 * Access the binary rendering engine.
 *
 * Creation date: (1/3/00 1:11:03 PM)
 * @return com.touchnet.base.BinaryRenderingEngine
 */
protected BinaryRenderingEngine getEngine()
    {
    if (null == engine)
        engine = new BinaryRenderingEngine();
    return engine;
    }
```

Fig. 4B

```
/**
 * Access the named field within the component
 */
public String getField(String name)
    throws TException
    {
    AbstractStructureTreeNode node = getNode(name);
    if (node instanceof FieldTreeNode)
        {
        FieldTreeNode fieldNode = (FieldTreeNode)node;
        return fieldNode.getField().toString();
        }

    // It's not a field, so this is an exception

    throw new TException("Attempt to access a non-field element as a field");

    }
/**
 * Access the name of the metadata that describes this component
 *
 * Creation date: (2/29/00 11:24:58 AM)
 * @return java.lang.String
 */
public String getMetadataName()
    {
    return metadataName;
    }
/**
 * This will access the named node, starting at the root of the embedded tree
 *
 * Creation date: (2/29/00 11:43:09 AM)
 * @return com.touchnet.beangen.AbstractStructureTreeNode
 * @param name java.lang.String
 * @exception com.touchnet.base.TException The exception description.
 */
protected AbstractStructureTreeNode getNode(String name)
    throws TException
    {
    StringTokenizer tokenizer = new StringTokenizer(name, "/");
    return getNode(tokenizer, getRoot());
    }
/**
 * This will access the named node, as a child of the current node.  The name
 * is the next element in the tokenizer.  If the name child doesn't exist, this
 * will throw an exception
 *
 * Creation date: (2/29/00 11:43:09 AM)
 * @return com.touchnet.beangen.AbstractStructureTreeNode
 * @param name java.lang.String
 * @exception com.touchnet.base.TException The exception description.
 */
protected AbstractStructureTreeNode
    getNode(StringTokenizer tokenizer, AbstractStructureTreeNode current)
    throws TException
    {
    if (!tokenizer.hasMoreElements())
        return current; // The current node is the requested node

    String child = tokenizer.nextToken();

    // Look for the name among the child nodes

    int count = current.getChildCount();
    for (int i = 0; i < count; ++i)
        {
        AbstractStructureTreeNode node =
                        (AbstractStructureTreeNode)current.getChildAt(i);
        if (node.getName().equals(child))
            return getNode(tokenizer, node);
        }
```

Fig. 4C

```
    // The name didn't match any of the children

    throw new TException("The child of '"+current.getName()+"' named '"+
                              child+"' does not exist");
    }
/**
 * This will access the root node for the legacy data layout
 *
 * Creation date: (1/3/00 12:56:48 PM)
 * @return com.touchnet.beangen.StructTreeNode
 */
protected StructTreeNode getRoot()
    {
    return root;
    }
/**
 * This will read the binary contents of the input stream and
 * place it in the appropriate nodes of the tree
 */
public void read(InputStream stream)
    throws TException
    {
    // Code not shown
    }
/**
 * Access the name of the architecture that describes the underlying
 * binary data.
 */
public void setArchitecture(String name)
    throws TException
    {
    architecture = name;
    return;
    }
/**
 * Set the array for this level in the data structure
 */
public void setArray(String name, StructureInterface[] child)
    throws TException
    {
    AbstractStructureTreeNode node = getNode(name);
    if (node instanceof ArrayTreeNode)
        {
        ArrayTreeNode arrayNode = (ArrayTreeNode)node;
        arrayNode.setArray(child);
        }

    // If this isn't an array node, then we tried to access a non-array
    // as an array

    throw new TException("Attempt to access a non-array element as an array");
    }
/**
 * Update the named field with the value
 */
public void setField(String name, String value)
    throws TException
    {
    AbstractStructureTreeNode node = getNode(name);
    if (node instanceof FieldTreeNode)
        {
        FieldTreeNode fieldNode = (FieldTreeNode)node;
        LegacyField field = fieldNode.getField();
        field.setValue(value);
        }

    // It's not a field, so this is an exception

    throw new TException("Attempt to access a non-field element as a field");
```

Fig. 4D

```
    }
/**
 * Access the name of the metadata that describes this component
 *
 * Creation date: (2/29/00 11:24:58 AM)
 * @param name java.lang.String
 */
public void setMetadataName(String name)
    {
    metadataName = name;
    return;
    }
/**
 * This will access the root node for the legacy data layout
 *
 * Creation date: (1/3/00 12:56:48 PM)
 * @param rootNode com.touchnet.beangen.StructTreeNode
 */
protected void setRoot(StructTreeNode rootNode)
    {
    root = rootNode;
    return;
    }
/**
 * This will write the binary contents back to the
 */
public void write(OutputStream stream)
    throws TException
    {
    // Code not shown
    }
}
```

Fig. 5A

```
package com.touchnet.beangen.generated;

import com.touchnet.beangen.*;
import com.touchnet.base.*;
/**
 * This was automatically generated 2/29/00 12:38:47 PM
 */
public class StudentSummaryInformation
    extends AbstractStructure
{
/**
 * StudentSummaryInformation constructor comment.
 */
public StudentSummaryInformation() {
    super();
}
public String getAddress(int index)
    throws TException
    {
    StructureInterface[] array = getArray("/ADDRESS");
    return array[index].getField("/");
    }
public String getGradePointAverage()
    throws TException
    {
    return getField("/GRADE-POINT-AVERAGE");
    }
public String getHousing()
    throws TException
    {
    return getField("/BALANCES/HOUSING");
    }
public String getIdNumber()
    throws TException
    {
    return getField("/ID-NUMBER");
    }
public String getName()
    throws TException
    {
    return getField("/NAME");
    }
public String getPhoneNumber()
    throws TException
    {
    return getField("/PHONE-NUMBER");
    }
public String getPIN()
    throws TException
    {
    return getField("/PIN");
    }
public String getSocialSecurityNumber()
    throws TException
    {
    return getField("/SOCIAL-SECURITY-NUMBER");
    }
public String getTuition()
    throws TException
    {
    return getField("/BALANCES/TUITION");
    }
public void setAddress(int nth, String value)
    throws TException
    {
    StructureInterface[] array = getArray("/ADDRESS");
    array[nth].setField("/", value);
    }
public void setGradePointAverage(String value)
    throws TException
    {
```

Fig. 5B

```
    setField("/GRADE-POINT-AVERAGE",value);
    }
public void setHousing(String value)
    throws TException
    {
    setField("/BALANCES/HOUSING",value);
    }
public void setIdNumber(String value)
    throws TException
    {
    setField("/ID-NUMBER",value);
    }
public void setName(String value)
    throws TException
    {
    setField("/NAME",value);
    }
public void setPhoneNumber(String value)
    throws TException
    {
    setField("/PHONE-NUMBER",value);
    }
public void setPIN(String value)
    throws TException
    {
    setField("/PIN",value);
    }
public void setSocialSecurityNumber(String value)
    throws TException
    {
    setField("/SOCIAL-SECURITY-NUMBER",value);
    }
public void setTuition(String value)
    throws TException
    {
    setField("/BALANCES/TUITION",value);
    }
}
```

Fig. 6

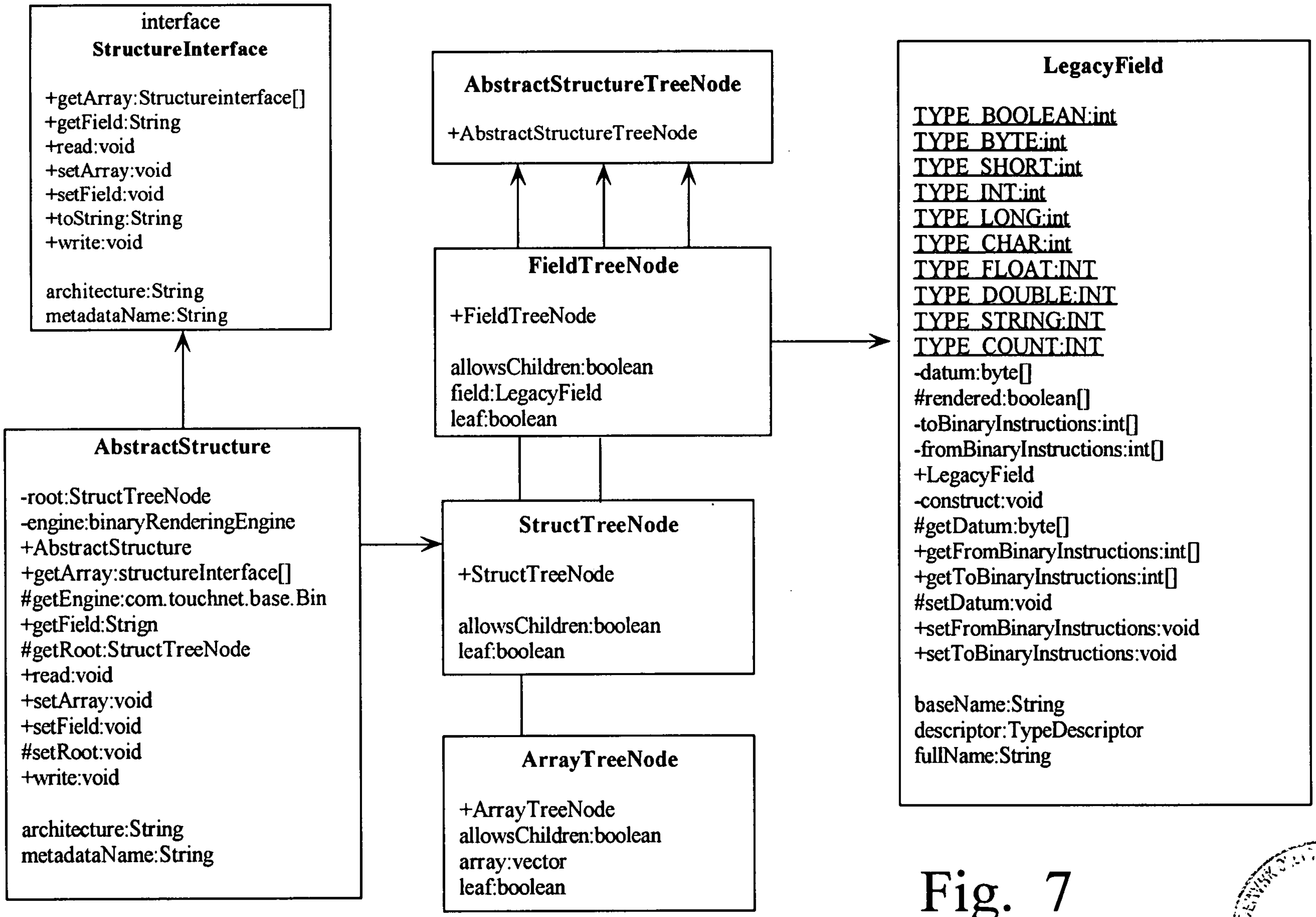

interface
StructureInterface
+getArray:Structureinterface[]
+getField:String
+read:void
+setArray:void
+setField:void
+toString:String
+write:void
architecture:String
metadataName:String
AbstractStructure
-root:StructTreeNode
-engine:binaryRenderingEngine
+AbstractStructure
+getArray:structureInterface[]
#getEngine:com.touchnet.base.Bin
+getField:Strign
#getRoot:StructTreeNode
+read:void
+setArray:void
+setField:void
#setRoot:void
+write:void
architecture:String
metadataName:String
AbstractStructureTreeNode
+AbstractStructureTreeNode
FieldTreeNode
+FieldTreeNode
allowsChildren:boolean
field:LegacyField
leaf:boolean
StructTreeNode
+StructTreeNode
allowsChildren:boolean
leaf:boolean
ArrayTreeNode
+ArrayTreeNode
allowsChildren:boolean
array:vector
leaf:boolean
LegacyField
TYPE_BOOLEAN:int
TYPE_BYTE:int
TYPE_SHORT:int
TYPE_INT:int
TYPE_LONG:int
TYPE_CHAR:int
TYPE_FLOAT:INT
TYPE_DOUBLE:INT
TYPE_STRING:INT
TYPE_COUNT:INT
-datum:byte[]
#rendered:boolean[]
-toBinaryInstructions:int[]
-fromBinaryInstructions:int[]
+LegacyField
-construct:void
#getDatum:byte[]
+getFromBinaryInstructions:int[]
+getToBinaryInstructions:int[]
#setDatum:void
+setFromBinaryInstructions:void
+setToBinaryInstructions:void
baseName:String
descriptor:TypeDescriptor
fullName:String

Fig. 7

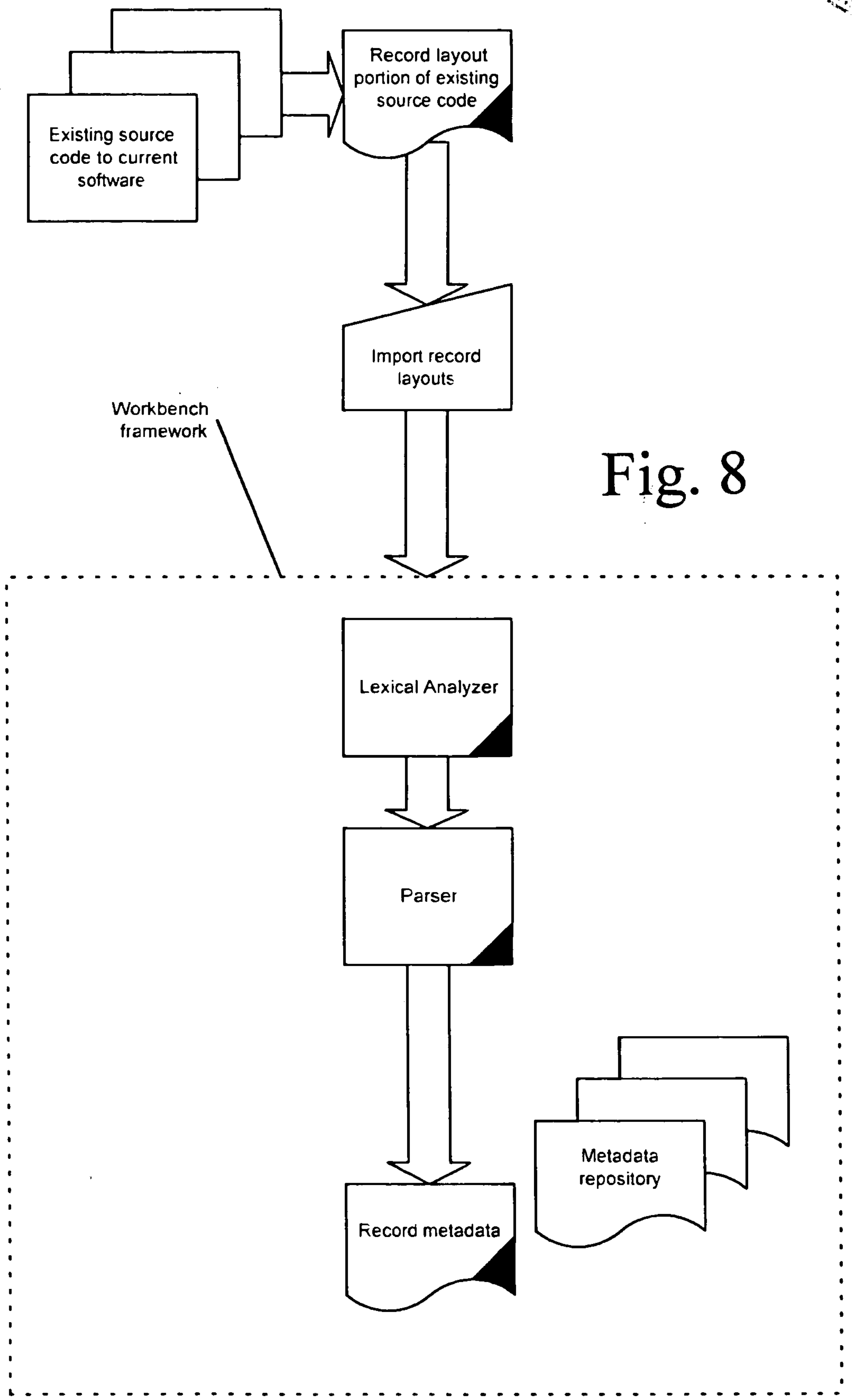

Existing source code to current software
Record layout portion of existing source code
Import record layouts
Workbench framework
Lexical Analyzer
Parser
Record metadata
Metadata repository

Fig. 8

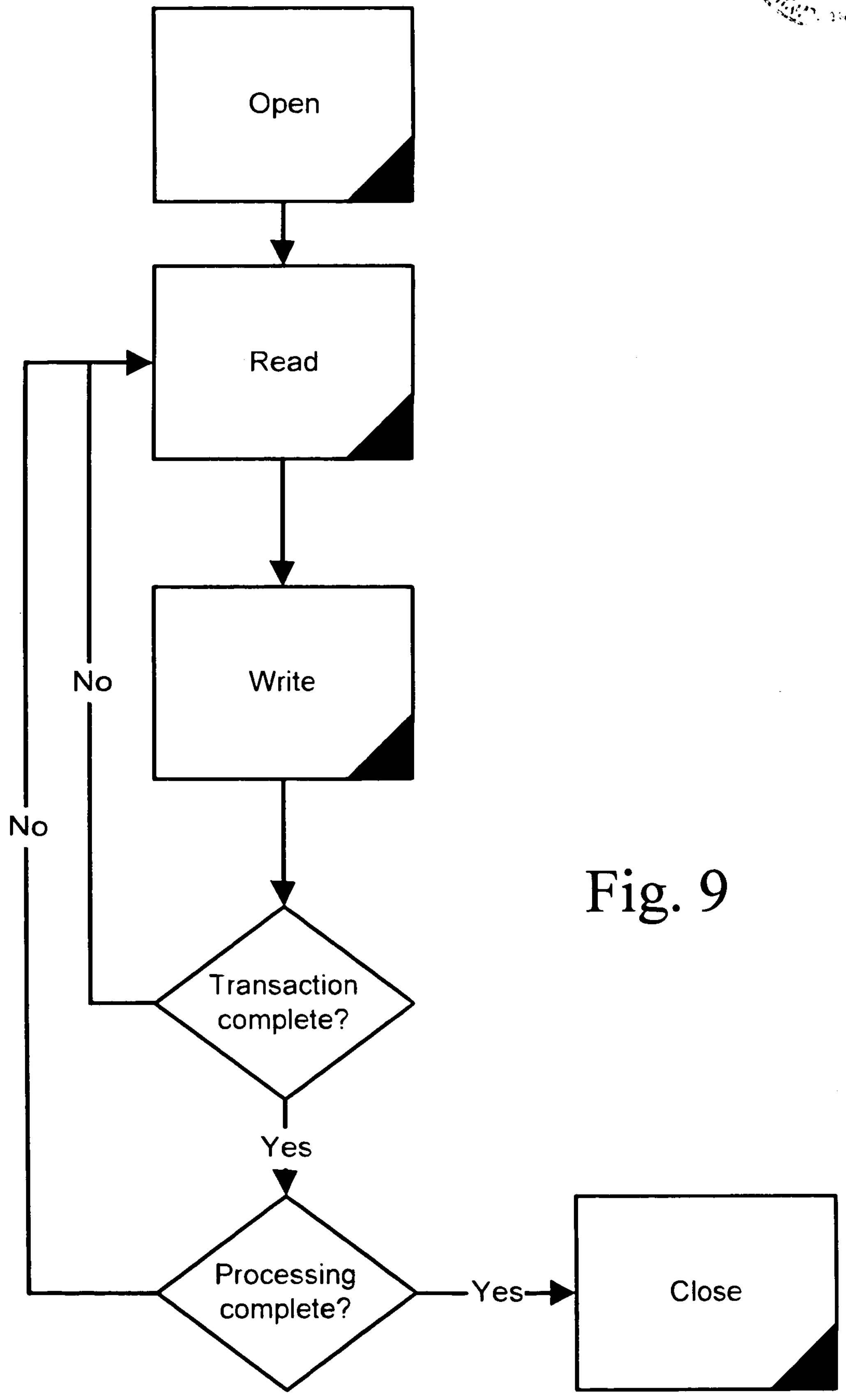
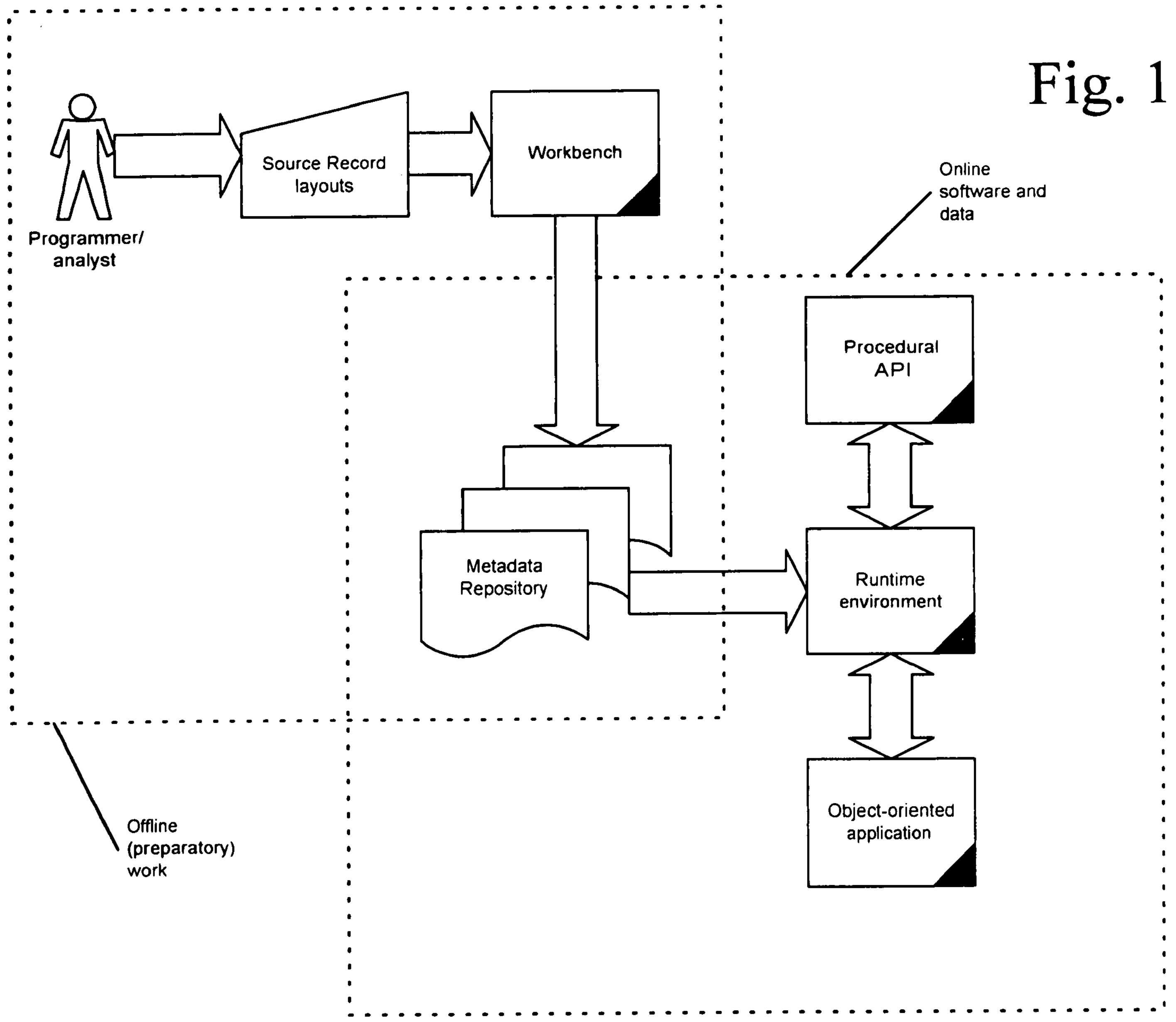

Open
Read
Write
No
No
Transaction complete?
Yes
Processing complete?
Yes
Close

Fig. 9

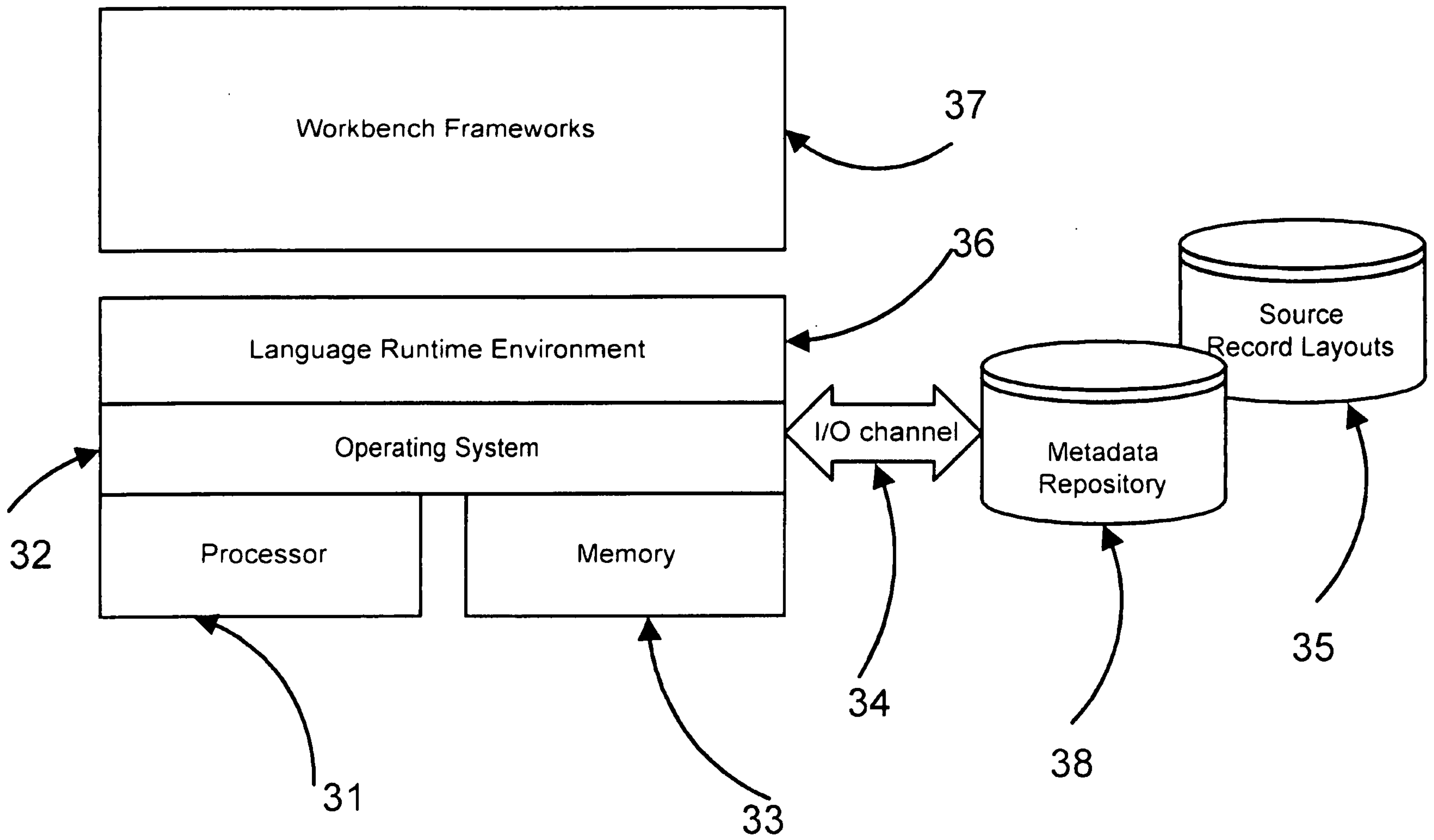
```
/* -- Published APIs and data types */

typedef long lxsHandle;

lxsHandle lxsOpen(char *id, char *host,
                  unsigned short port);
int       lxsClose(lxsHandle handle);
int       lxsRead(lxsHandle handle, char *name, void *data, unsigned long length);
int       lxsWrite(lxsHandle handle, char *name, void *data, unsigned long length);
int       lxsCommit(lxsHandle handle);
int       lxsRollback(lxsHandle handle);
void      lxsGetLastNameRead(lxsHandle handle, char *name);
```

Fig. 10



Programmer/ analyst
Source Record layouts
Workbench
Online software and data
Procedural API
Metadata Repository
Runtime environment
Object-oriented application
Offline (preparatory) work

Fig. 11



Workbench Frameworks
37
36
Language Runtime Environment
Operating System
Processor
Memory
32
31
33
I/O channel
34
Metadata Repository
38
Source Record Layouts
35

Fig. 12

```
package com.touchnet.util.base;

//***<copyright>*************************************************************
//*
//*          Copyright (c) 2000
//*          TouchNet Information Systems, Inc.
//*          All Rights Reserved
//*
//*  This program is an unpublished copyright work of TouchNet Information
//*  Systems, Inc. of Lenexa, KS.  The program, all information disclosed
//*  and the matter shown and described hereon or herewith are confidential
//*  and proprietary to TouchNet Information Systems, Inc.
//*
//***<copyright>*************************************************************
//*
//* Change Log:
//* $Log: BinaryRenderingEngine.java $
//* Revision 1.4  2000/07/19 10:36:36  glm
//*
import com.touchnet.util.base.*;
import com.touchnet.util.*;
import java.math.BigInteger;
/**
 * This is a utility object that will manage the bit/byte manipulation
 * for a variety of data conversions.
 */
public class BinaryRenderingEngine
    {

/**
 * Construct an object that will render byte arrays in a variety
 * of formats
 *
 */
public BinaryRenderingEngine()
    {
    super();
    }
/**
 * Access the value that is used when there is a rendering error
 *
 * @return byte
 */
public byte getErrorByte()
    {
    return errorByte;
    }
/**
 * Return a copy of one of these.
 *
 * @return COM.touchnet.xmlhost.BinaryRenderingEngine
 */
public static BinaryRenderingEngine getInstance()
    {
    if (instance == null)
        instance = new BinaryRenderingEngine();
    return instance;
    }
/**
 * This is called when there is a formatting exception such as a
 * string representation of a number that overflows the number of
 * bytes that number can handle
 *
 * @param data byte[]
 * @param exception java.lang.NumberFormatException
 */
public void handleFormatException(byte[] data, IllegalArgumentException exception)
    {
    // For now, we just set the bytes to some pre-defined value.  We may want
    // to make this a JavaBean that fires an formatting exception event to
    // the listeners.
```

Fig. 13A

```
    byte err = getErrorByte();
    for (int i = 0; i < data.length; ++i)
        data[i] = err;
    return;
    }
/**
 * This will parse the string into a long
 *
 * Creation date: (7/12/00 11:21:57 AM)
 * @return long
 * @param number java.lang.String
 */
private long parseLong(String number)
    {
    if (0 == number.length())
        return 0;

    // The Java parseLong() is pretty stupid.  It can't handle a leading '+', so I need
    // an explicit check for that.

    if ('+' == number.charAt(0))
        number = number.substring(1);

    return Long.parseLong(number);
    }
/**
 * Render a Java String from a series of bytes with 7-bit ASCII values
 *
 * @return java.lang.String
 * @param datum byte[]
 */
public String renderAsciiString(byte[] datum)
    {
    int size = datum.length;
    char[] array = new char[size];
    for (int i = 0; i < size; ++i)
        array[i] = (char)renderPrintableAscii(datum[i],' ');

    return String.valueOf(array);
    }
/**
 * This will return a byte array containing 7-bit ASCII values generated
 * from the number passed
 *
 * @return byte[]
 * @param value int
 * @param size int
 * @param pad char
 */
public byte[] renderAsciiString(int value, int size, char pad)
    {
    byte[]  buffer   = new byte[size];
    int     offset   = 0;
    boolean negative = false;

    if ((value < 0) && (pad != ' '))
        {
        value = 0 - value;
        negative = true;
        buffer[offset++] = (byte)'-';
        }

    String string = Integer.toString(value);
    int length = string.length();
    for (; offset < size - length; ++offset)
        buffer[offset] = (byte)pad;  // Pad on left if needed

    byte[] stringBytes = string.getBytes();
    for (int i = 0; offset < size; ++offset, ++i)
        buffer[offset] = stringBytes[i];
```

Fig. 13B

```
    return buffer;
    }
/**
 * This will render the two bytes in the array into an
 * integer and return the string rendering of that
 *
 * @return java.lang.String
 * @param raw byte[]
 */
public String renderBigEndian16Bit(byte[] raw)
    {
    short byte0 = (short)raw[0];  // Allow this to sign-extend
    short byte1 = (short)(raw[1] & 0x00FF);

    short value =
        (short)((byte0 << 8)
            -       byte1
                );
    return String.valueOf(value);
    }
/**
 * This will render the string numeric into two bytes
 *
 * @param java.lang.String
 * @return raw byte[]
 */
public byte[] renderBigEndian16Bit(String datum)
    {
    byte[] raw = new byte[2];
    short value  = 0;
    try
        {
        value = parseShort(datum);
        raw[0] = (byte)((value & 0x0000FF00) >> 8);
        raw[1] = (byte)( value & 0x000000FF);
        }
    catch(NumberFormatException exception)
        {
        handleFormatException(raw, exception);
        }
    return raw;
    }
```

Fig. 13C

```
    .
    .
    .

 /**
  * This will take a series of bytes which are expected to be
  * ASCII characters representing numbers, for example:
  *
  *   { '-','6','9','6','0' }
  *
  *
  * would be -6960.  It will return an int.
  *
  * @return int
  * @param raw byte[]
  */
 public int renderIntegerFromAsciiBytes(byte[] raw)
     {
     String number = renderAsciiZString(raw).trim();

     if ("".equals(number)) // All white space is considered a valid zero integer
         return 0;

     int value  = 0;
     try
         {
            value = parseInt(number);
            }
        catch(NumberFormatException exception)
            {
            handleFormatException(raw, new NumberFormatException());
            return -1;
            }
        return value;
        }

        .
        .
        .

    /**
     * This will render bytes representing a packed decimal field int
     * a string representation.  This is a helper routine that work
     * for both signed and unsigned packed value
     *
     * @return java.lang.Strin
     * @param raw byte[]
     * @param isSigned boolea
     */
    private String renderPacked(byte[] raw, boolean isSigned, int offset)
        {
        char          signCharacter = ' ';  // Assume no sig
        StringBuffer buffe         = new StringBuffer();
        boolea       minu          = false;

        // Take a peek at the offset compared to the length of the raw data and se
        // where the decimal point goes.

        int appen        = 0;
        int insertAfter = -1;
        int digit        = (raw.length << 1) - 1;

        if (offset > 0) // Append only
            append = offset;
        els
            {
            // We have a negative offset, the decimal will either be to the left o
            // somewhere in the middle.

            insertAfter = digits + offset;  // Add because offset is negativ
            if (insertAfter < 0) // The offset means only leading zeros...
                {
                buffer.append('.');
                for (int i = insertAfter; i < 0; ++i)
                    buffer.append('0');
                }
            } // els

        int      rIndex        = -1; // Index into the raw dat
        int      nibbl         = 0;
        boolean secondNibble = true;

        for (int i = 0; i < digits; ++i)
            {
            if (secondNibble)  // Bump input byte every other nibbl
                ++rIndex;
            secondNibble = !secondNibble;

            // Wait for the interation in which we have to stuff the extra decima
            // point.

            if (i == insertAfter)
                buffer.append('.');
            if (secondNibble)
                nibble = raw[rIndex] & 0x0000000F;
```

Fig. 13D

```
        else
            nibble = (raw[rIndex] >> 4) & 0x0000000F;

        switch(nibble)
            {
            case 0: buffer.append('0'); break;
            case 1: buffer.append('1'); break;
            case 2: buffer.append('2'); break;
            case 3: buffer.append('3'); break;
            case 4: buffer.append('4'); break;
            case 5: buffer.append('5'); break;
            case 6: buffer.append('6'); break;
            case 7: buffer.append('7'); break;
            case 8: buffer.append('8'); break;
            case 9: buffer.append('9'); break;
            default:
                handleFormatException(raw,
                        new IllegalArgumentException("Invalid value in data"));
                return "[data format error]";
            } // switch
        } // for

    // Now handle the last nibble which is the sign.

    nibble = raw[rIndex] & 0x0000000F;
    switch(nibble)
        {
        case 0x0A:
        case 0x0C:
        case 0x0E:
        case 0x0F:
            break;
        case 0x0D:
        case 0x0B:
            minus = true;
            break;
        default:
            {
            handleFormatException(raw,
                new IllegalArgumentException("Invalid value in data"));
            return "[data format error]";
            }
        }

    // Append any additional trailing zeros that are a result of the decimal shift
    // in the type descriptor

    for (int i = 0; i < append; ++i)
        buffer.append('0');

    String rendered = buffer.toString();
    if (isSigned && minus)
        rendered = '-' + rendered;
    return rendered;
    }
/**
 * This is a helper method that will render PIC templates that have been pre-determined
 * to be numeric.  It will handle both EBCDIC or ASCII input numerics.
 *
 * @return byte[]
 * @param raw java.lang.String
 * @param template byte[]
 * @param offset int
 * @param isAscii boolean
 */
private byte[] renderPacked(String raw, int size, int offset, boolean isSigned)
    {
    byte[]          buffer  = new byte[size];
    int             shift   = 0;  // This is the decimal place shift that we find in the
                                  // data.  It is used to reconcile the offset parm.
    boolean         decimal = false; // ... until we hit a decimal point, then it is true
```

Fig. 13E

```
boolean     minus  = false;
byte[] userdata = raw.getBytes();
byte[] numeric  = new byte[userdata.length];  // Just the numeric part of the data
int    numSize  = 0; // Count of just the numerics in the user data

for(int i = 0; i < userdata.length; ++i)
    {
    switch(userdata[i])
        {
        case (byte)'0':
        case (byte)'1':
        case (byte)'2':
        case (byte)'3':
        case (byte)'4':
        case (byte)'5':
        case (byte)'6':
        case (byte)'7':
        case (byte)'8':
        case (byte)'9':
            numeric[numSize++] = (userdata[i]);
            if (decimal) ++shift;
            break;

        case (byte)'-':
            minus = true;
            break;
        case (byte)'+':
            break;
        case (byte)'.':
            decimal = true;
            break;
        } // switch
    } // for

// Now we have the digits separated from the sign and decimal point.  Now
// we have to normalize the decimal offset and the digit count with the
// template.  What makes this additionally complex is the observation that
// there can be truncation on either side of the user data if the shift
// overflows the template.  Consider the following examples:
//
// Assume:
//
//    template = 99999 with shift -2 (via PIC 999V99)
//
//    Userdata    Answer
//    --------    ------
//    1230        23000  (truncation on left)
//    123         12300
//    12.3        01230
//    1.23        00123
//    .123        00012  (truncation on right)
//
//    At this point in the code, we have the user data filtered out
//    into a the string "123".  We need to align the decimal point
//    logically based on the shifts in the template minus the logical
//    shifts from the explicit decimal point in the data.

int    index  = numSize - ((size << 1) - 1) - offset - shift;
int[]  value  = new int[2];
for (int i = 0; i < size-1; ++i)
    {
    for (int j = 0; j < 2; ++j)
        {
        if (index < 0)
            value[j] = 0;
        else
        if (index < numSize)
            value[j] = numeric[index] & 0x0000000F;
        else
            value[j] = 0;
        ++index;
```

Fig. 13F

```
                }
            buffer[i] = (byte)((value[0] << 4) | value[1]);
            }

        // Do the last byte as a special case since it contains the sign nibble

        for (int j = 0; j < 2; ++j)
            {
            if (index < 0)
                value[j] = 0;
            else
            if (index < numSize)
                value[j] = numeric[index] & 0x0000000F;
            else
                value[j] = 0;
            ++index;
            }
        int sign = 0x0C;  // Plus
        if (isSigned && minus)
            sign = 0x0D;
        buffer[size-1] = (byte)((value[0] << 4) | sign);
        return buffer;
        }

        .
        .
        .
    }
```

Fig. 13G